



Student Study Guide



Mountain hemlock trees survive the winter at Crater Lake. NPS Photo

Name: _____

People protect everything at Crater Lake National Park. For the last 100 years, park rangers have protected living things like pikas and mountain hemlocks, non-living things like rocks and water, and even ideas like wilderness and spirituality. For at least 10,000 years, local American Indian tribes have protected the stories of the place's violent past.

These people all practice **stewardship**. You can practice stewardship today by learning about what makes Crater Lake special. In the future, you can visit and create your own reasons to love our national parks.

Stewardship

protecting something
important in a
responsible way

Glossary of keywords on back page

Meet the American pika!

Pikas (pai-kuhs) are about the size of hamsters. They live year-round on mountainsides and they don't hibernate! They only survive in air temperatures about as cold as a refrigerator—not freezing, but not as warm as your classroom. In fact, a pika could not survive in your classroom! Do you think you could survive on a mountainside?



An American pika keeps watch for predators. NPS Photo

Crater Lake used to be a giant *volcano* named Mount Mazama.

Mount Mazama erupted regularly for half a million years. It grew larger and taller as layers of lava cooled on top of each other.

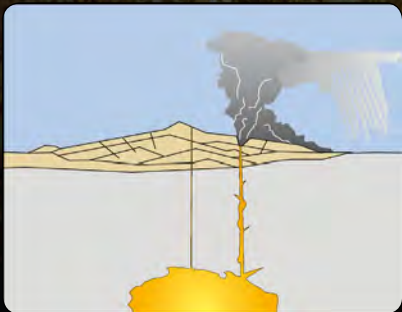
Then during one enormous eruption Mount Mazama disappeared.

A Scientific Story

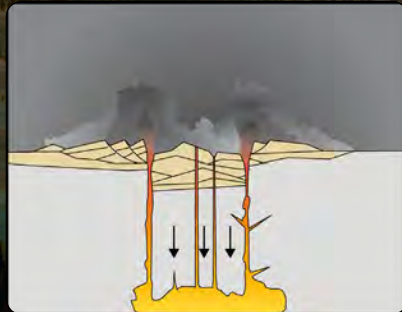
After studying lava rocks inside of the **caldera** and **volcanic ash** spread across the globe, **volcanologists** wrote a story of the geologic formation of Crater Lake. This story changes as more scientists research the caldera. Although the Crater Lake caldera is one of the most researched volcanoes in the world, mysteries remain.

Mystery: What will happen to the lake if the Crater Lake caldera erupts?

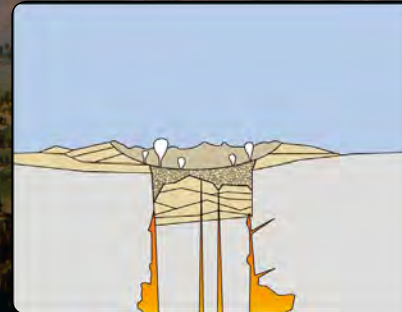
Step 1: The **magma chamber** beneath Mount Mazama overfilled with **magma**. Too much pressure led to a cataclysmic eruption.



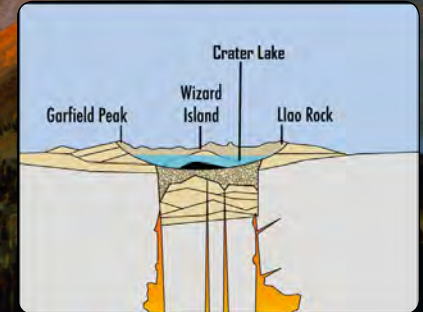
Step 2: **Lava** erupted into the sky, the volcano crumbled and collapsed into the empty magma chamber.



Step 3: After the eruption, the newly formed caldera filled with lava and debris, sealing off its bottom.



Step 4: **Precipitation** fell into the caldera and filled it with fresh water, creating the deepest lake in the USA (1,943 feet deep)!

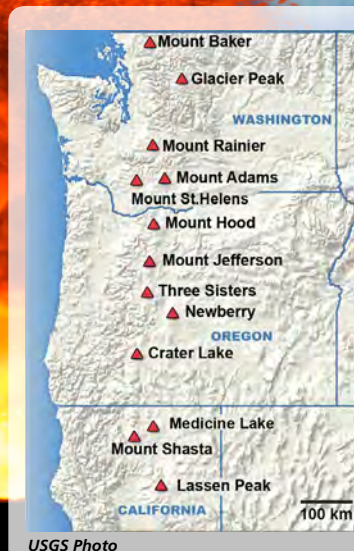
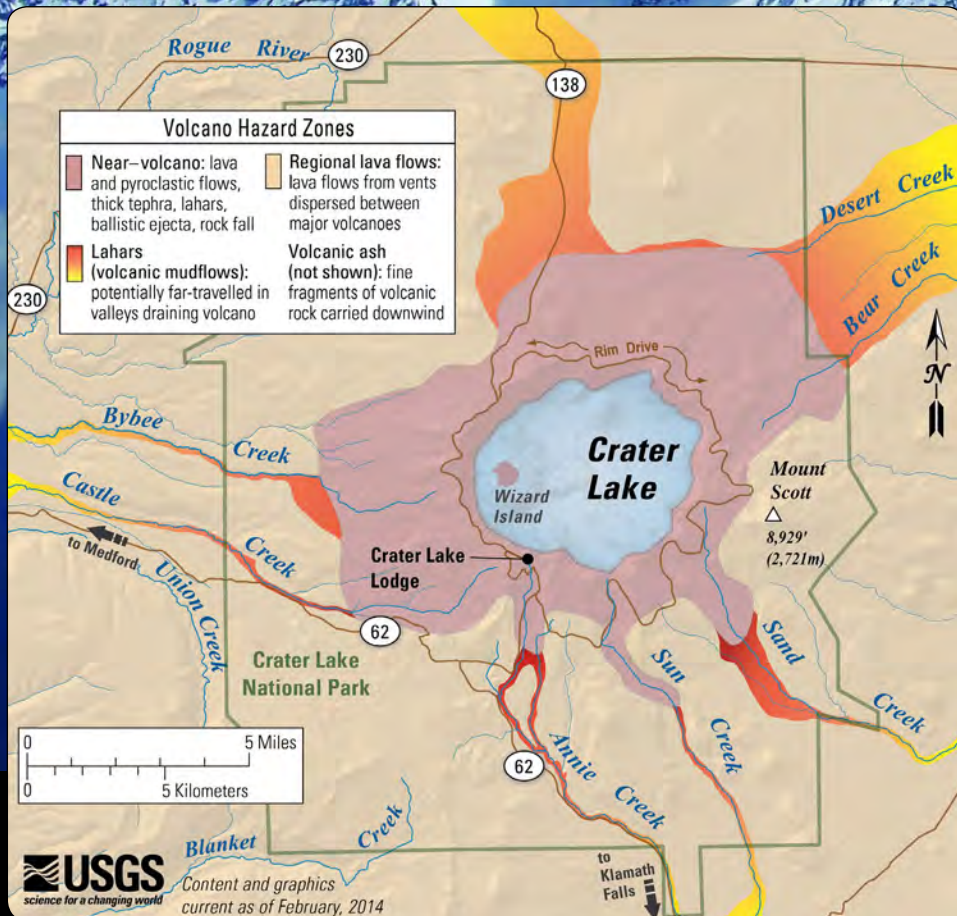


Is it safe to visit Crater Lake today?

Scientists studying the lake floor with submarines determined that the Crater Lake caldera is dormant, but still poses risks to humans. Volcanologists monitor Crater Lake for tectonic activity 24/7 to help keep people safe. They're looking for earthquakes that might warn us about future eruptions!

Don't worry! Park rangers won't let you near the volcano if there have been recent signs of volcanic activity!

[Click here to learn more about volcanic hazards at Crater Lake!](#)



The High Cascades

The Crater Lake caldera is one of thirteen major volcanoes in the High Cascades Range that spans from northern California to southern British Columbia. Eleven of the thirteen volcanoes have erupted in the past 4,000 years, and seven of those have erupted in the past 200 years. Mount Mazama's cataclysmic eruption (7,700 years ago) was the largest eruption in the High Cascades in the last million years! Volcanologists consider these volcanoes to be dormant, meaning they could all erupt again.

Do you live near one of these dormant volcanoes?

The Klamath Tribes (Klamath, Modoc, and Paiute-Snake) are the original *stewards* of Crater Lake. For these people, the lake and surrounding peaks are the most important places on Earth. Knowledge of Mount Mazama and the surrounding landscape has been passed down for thousands of years.

Knowledge of a violent, volcanic landscape

Orin "Buzz" Kirk, an elder member of the Klamath Tribes, tells of eruptions from both Yamsay Mountain and Mount Mazama. Kirk's ancestors witnessed the eruptions and believed the mountains were fighting because as soon as one volcano erupted the other would erupt in retaliation. This account has been passed down for countless generations. Kirk was given this story by his grandfather (Seldon Kirk, elder and tribal chairman) in 1954, when he was 14 years old.

Geologists estimate that Yamsay Mountain (35 miles east of the Crater Lake caldera) has been dormant for about 11,000 years. This means that Kirk's traditional knowledge of the area goes back more than 11,000 years.

How do we know that American Indians lived near Mount Mazama over 10,000 years ago?

In 1938, Archaeologist Luther Cressman discovered dozens of shoes made of sagebrush bark in Fort Rock Cave (60 miles from Crater Lake). They were buried under the volcanic ash that erupted from Mount Mazama 7,700 years ago. This means they had to have been made before the great eruption. Carbon dating reveals that they were hand-crafted about 10,000 years ago!

A dancer holds his daughter at the Annual Klamath Tribes Reconciliation Celebration. Photo: Meta J. Maxwell

The Legend of the Lake
By June Poitras,
from Vina Kirk's collection, circa 1940

Many, many moons before the coming of the pale ones, a band of brave Klamath hunters came unexpectedly upon a great bowl in a mountaintop. They were struck dumb with the beautiful yet fearsome sight of the majestically steep walls and the water below which was bluer than the wing of a jay. Most fearfully they gazed over the edge of the steep cliffs to the motionless depths below. They sensed that here indeed dwelt the Great Spirit and they bowed in frightened humility and reverence. They crept back down the mountainside and camped at a safe distance.

One young brave, though weary from a day of hunting, found no rest by the flickering fire. He lay on his back and looked into the depths of the stars and he felt the presence of the Great Spirit. Silently he arose and walked back and forth. His moccasins turned again toward the blue lake. He could not help himself. He stood on the edge high above the smooth water. Finally he built a small fire and lay down. He closed his eyes and then heard voices rising from the deep water. His spirit seemed soothed and happy. He slept soundly.

When he awoke the sun was high up and getting very warm. He went quickly and joined his fellow hunters far down the mountain. Again at night he was unable to sleep and the voices calling him from the blue waters became too strong for him. Standing again high above the lake he was filled with exultation.

Again the voices soothed him like a lullaby and he slept. Again and again he spent the night above the lake and each time seemed to get more strength.

After many nights on the cliff he was drawn irresistibly to climb down the steep walls to the waters. He bathed himself in the cool, blue depths. He saw mysterious beings glide to the surface; they resembled his brothers except they lived in the water. Again and again he returned to spend the night and to bathe. Suddenly, he became hardier and much stronger than the other hunters. He had much more power than any other member of the entire Klamath tribe.

When the others realized that he got his power from the depths of the lake, they too found the courage to bathe there. Old warriors sent their sons to visit this region and receive strength to cope with neighboring tribes in battle and to be successful hunters. The Klamaths knew then that Llaos dwelling in the lake made it powerful.

One evening a young brave, becoming proud and arrogant over his marvelous strength, dared to slay a monstrous fish that appeared at the surface of the water. Suddenly the infuriated Llaos swarmed to the surface and quickly killed the young dare devil. They tore his body into small pieces which they threw to their children in the blue depths.

Never again could anyone get strength from the blue water. The magic was gone. No Klamath dared venture near the home of the angry Llaos.

10,000 year old sagebrush bark sandals excavated from Fort Rock Cave. Photo: University of Oregon

[Click here to learn more about the Klamath Tribes!](#)

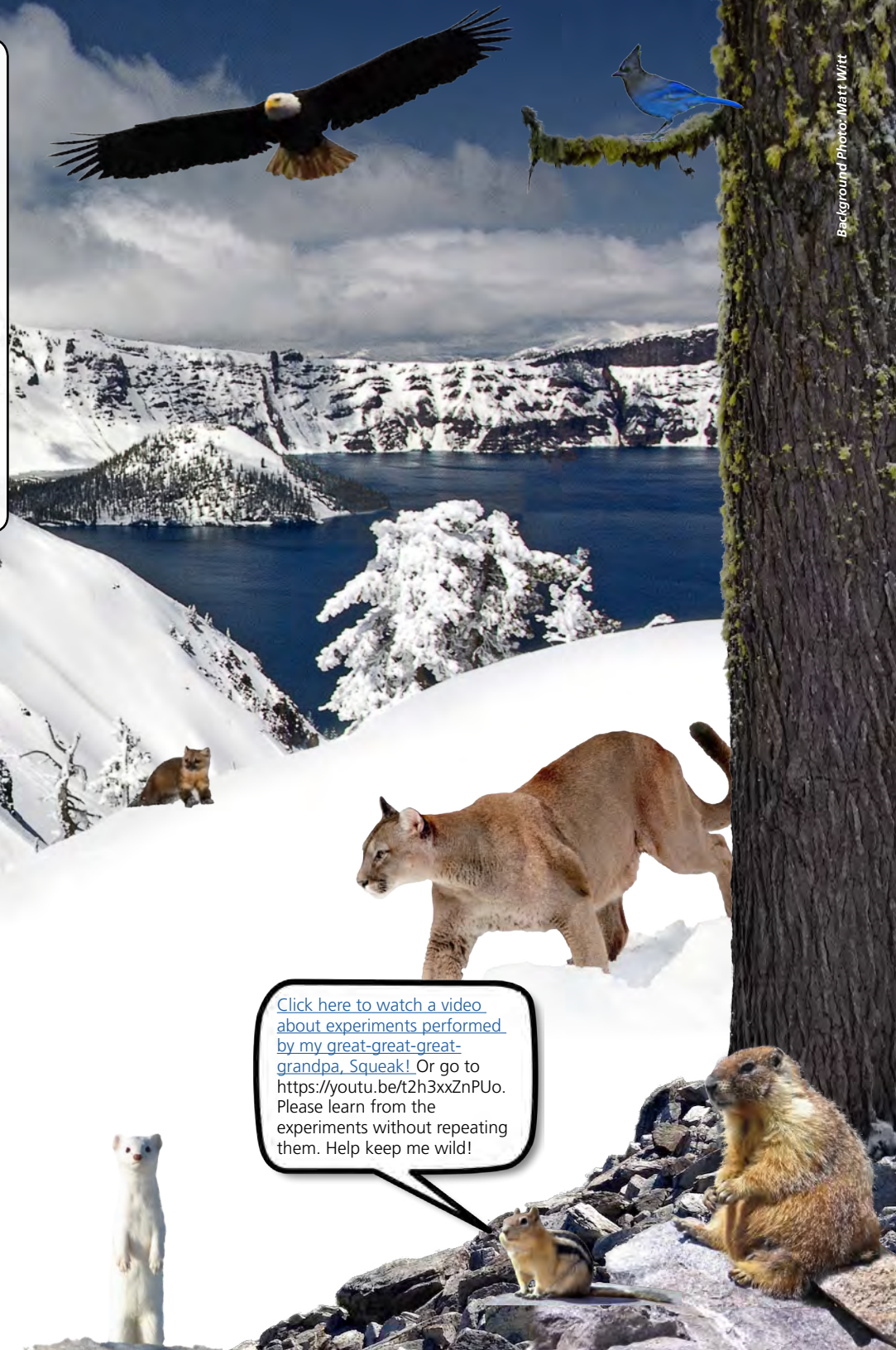
What kinds of living things survive at Crater Lake?

The life cycles of many organisms at Crater Lake depend on snow. Some species' winter **adaptations** are so extreme that they cannot survive in other types of habitats. When winter begins, some organisms go dormant or **hibernate**, some become extra active, and some **migrate** to warmer climates.

represents some of the living things that you might see at Crater Lake in the spring. After winter, longer days and warmer afternoon temperatures melt and refreeze snow forming a firmer **snowpack**. This process allows animals to walk on top of the snow and collect food throughout the park. However, these species only have about four months to enjoy the warmth and get ready for another snow season. The snow season at Crater Lake can last for eight months!

Can you name five of the living things in the collage? An answer key is on the back page!

This photo collage



[Click here to watch a video about experiments performed by my great-great-grandpa, Squeak!](https://youtu.be/t2h3xxZnPUo) Or go to <https://youtu.be/t2h3xxZnPUo>. Please learn from the experiments without repeating them. Help keep me wild!

The luck of the draw...

Precipitation can meet very different fates when falling to Crater Lake National Park. Will it land inside or outside of the caldera?

Landing inside of the caldera

Precipitation that falls into the caldera either lands directly on the lake's surface or on the caldera's steep inner walls. Either way, the water ends up in Crater Lake.

The Crater Lake caldera is its own closed **watershed**. This means that no streams or rivers flow into it from outside of the caldera. This makes the lake incredibly pure and blue.

Crater Lake doesn't overflow or dry up because it has an overflow drain (like a bathtub). Water seeps through the northern wall of the caldera, about 500 feet lower the lowest point on the caldera's rim. Scientists don't know where the water goes!

Annie Creek flows from a spring near Park Headquarters, providing the park's drinking water. Photo: Dave Harrison

Landing outside of the caldera

Precipitation that falls onto the outer slopes of the caldera becomes **runoff** and flows into three major watersheds: the Klamath, the Rogue, and the Umpqua.

After landing, rain mostly flows downhill, but snow sticks to the mountains. Because the snowpack's incredible depth, it melts slowly and soaks into the volcanic soils. This water slowly flows underground until it emerges from hundreds of freshwater springs surrounding the caldera. These springs provide water for drinking, recreation, agriculture, and wildlife from the park all the way to the Pacific Ocean!

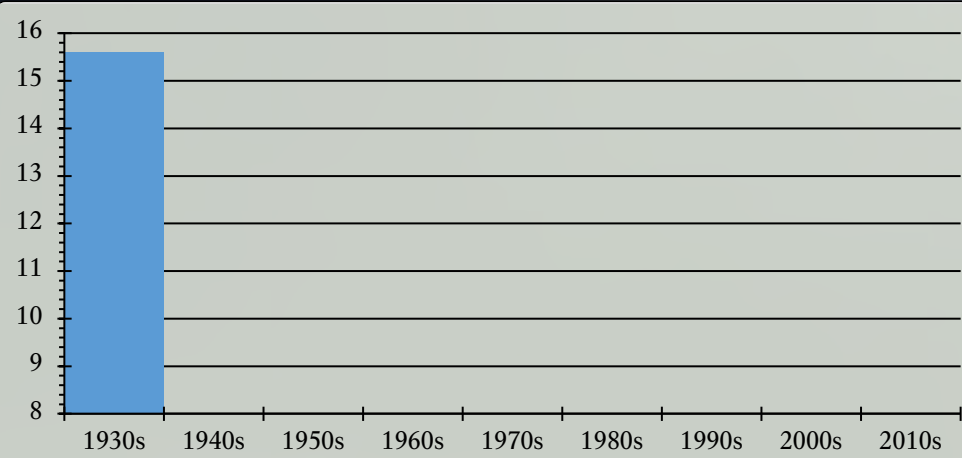
Only a deep snowpack will provide enough runoff to continue to feed these springs throughout the dry months of the summer. Therefore, even species living outside of the park depend on snowy winters at Crater Lake.

Water is a valuable natural resource.

Crater Lake provides visitors with beauty, recreation, and a window into a dormant volcano. One resource it provides is perhaps the most important—**WATER**.

The jagged peaks surrounding Crater Lake are the only visible remains of Mount Mazama. The summits are between 8,000 and 9,000 feet above sea-level. They are some of the highest in Oregon, and they are only 80 miles from the Pacific Ocean. Crater Lake's mountain peaks catch the clouds as they blow from the Pacific Ocean, raising them high into the atmosphere. The clouds cool as they rise, creating precipitation that falls onto the peaks and into the lake.

Average Annual Snowfall (meters)



Average Annual Snowfall

1930s - 15.6m
 1940s - 15.8m
 1950s - 14.5m
 1960s - 12.9m
 1970s - 12.6m
 1980s - 12.1m
 1990s - 12.5m
 2000s - 11.6m
 2010s - 9.6m



A ski jumper flies above Park Headquarters in the winter of 1932. NPS Photo

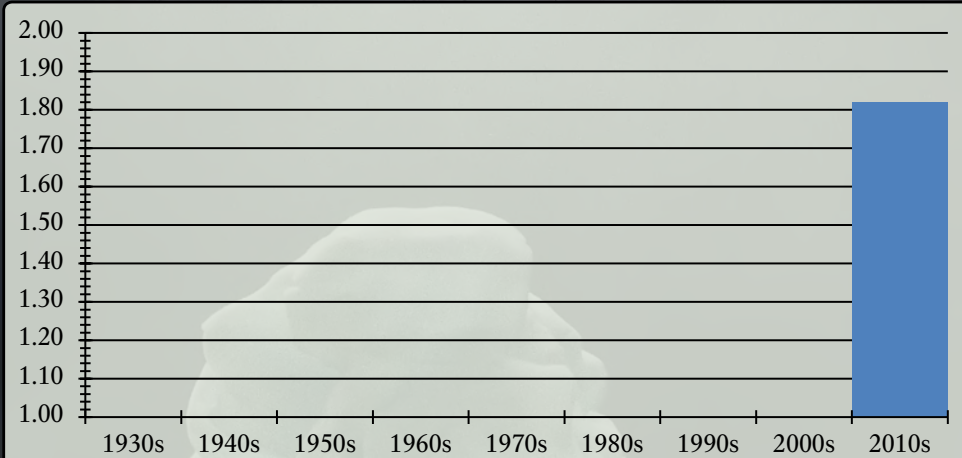
How has the climate changed at Crater Lake?

The National Park Service has measured snowfall every day at Crater Lake since 1931. Because **weather** changes daily, rangers use mathematics to average the weather data they collect. These averages describe Crater Lake's **climate**.

Above, the tables display average annual **snowfall** and **precipitation** (in meters) for each decade that rangers made measurements. **Draw two bar graphs in the spaces above, one for snowfall and one for precipitation.**

[Click here to watch a video about how rangers measure snow at Crater Lake!](#)

Average Annual Precipitation (meters)



Average Annual Precipitation

1930s - 1.62m
 1940s - 1.82m
 1950s - 1.83m
 1960s - 1.63m
 1970s - 1.68m
 1980s - 1.68m
 1990s - 1.75m
 2000s - 1.53m
 2010s - 1.82m

After completing the graphs, choose the best answers to the following questions...

- Crater Lake has experienced...
 - a) a trend of *increasing snowfall* since the 1930s.
 - b) a trend of *decreasing snowfall* since the 1930s.
 - c) *no trend* of increasing or decreasing **snowfall** since the 1930s.
- Crater Lake has experienced...
 - a) a trend of *increasing precipitation* since the 1930s.
 - b) a trend of *decreasing precipitation* since the 1930s.
 - c) *no trend* of increasing or decreasing **precipitation** since the 1930s.
- How do you think air temperature at Crater Lake has changed over time?
 - a) a trend of *increasing temperature* since the 1930s.
 - b) a trend of *decreasing temperature* since the 1930s.
 - c) *no trend* of increasing or decreasing **temperature** since the 1930s.

Managing Ecosystems

Park rangers protect Crater Lake National Park's ecosystems by carefully supporting the species that need the most help, and controlling the ones that cause the most harm. Species that need help to survive are called **at-risk species**, while species that cause harm to an ecosystem are called **invasive species**.

Invasive species

No matter how hard rangers work, invasive species are a huge challenge to control.

Invasive animals are commonplace at Crater Lake. Park founder William Steel introduced several species of sport fish into the lake in 1888. These newcomers are predators and they altered the food chain in a way that we may never understand. Today, the invasive animals that harm Crater Lake most are the crayfish that were introduced as fish bait! [Click here to watch a video about invasive crayfish!](#)

Every year, park botanists find more invasive plants, brought to the park mainly on tires and shoes. [Click here to watch a video about invasive plant species in the park!](#)



Invasive crayfish caught in a trap in Crater Lake.
Photo: Katie Campbell KCTS9/EarthFix.
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At-risk species

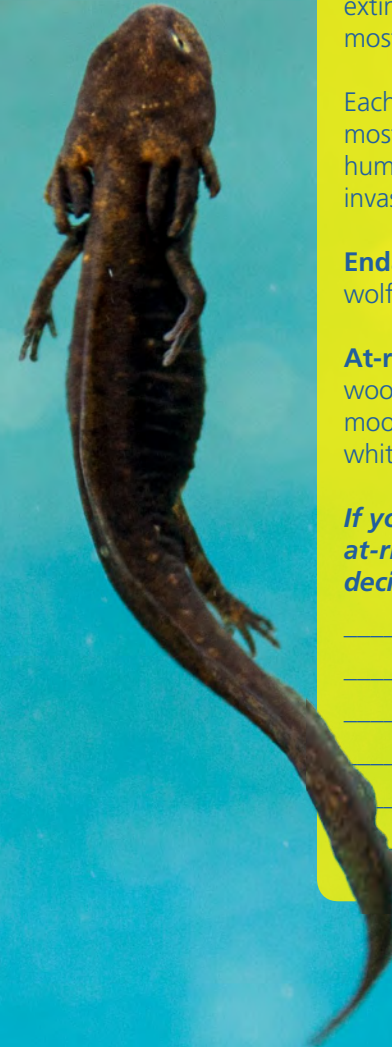
A population of species can be in danger without technically being "endangered." A population is at-risk when it suffers habitat loss, disease, or predation that could cause it to go extinct. Only the species that are in the most trouble are labeled as endangered.

Each species has its own story, but most troubles at Crater Lake arise from human impacts, like the introduction of invasive species and climate change.

Endangered species: bull trout, gray wolf, northern spotted owl

At-risk species: black-backed woodpecker, Mazama newt, pumice moonwort, Sierra Nevada red fox, whitebark pine

If you couldn't save all of park's at-risk species, how would you decide which ones to help?



A Mazama newt swims freely in Crater Lake. NPS Photo

Glossary of Keywords

adaptation

an inherited trait that improves an organism's chance of survival

at-risk species

a species whose population is at risk of extinction

caldera

a collapsed volcano, observed as a large depression in the ground

climate

the average weather conditions of a place over a period of years

hibernate

to become inactive or dormant to avoid an extreme climate

invasive species

a non-native species that causes harm to the environment

lava

rock that erupted from a volcano; can be molten or solid

magma

the name for molten rock when it is underground

magma chamber

an enormous pool of magma beneath the Earth's surface

migrate

to travel from one region to another to find food or mates

precipitation

any type of water falling from clouds—rain, snow, hail, etc.

runoff

precipitation that has landed and is flowing downhill

snowfall

the amount of snow that falls over a specified period of time

snowpack

the amount of snow that accumulates during a year

steward

a person that is responsible for protecting something important

stewardship

protecting something important in a careful and responsible way

volcanic ash

the smallest pieces of lava that erupt from volcanoes

volcano

a vent in Earth's crust that ejects molten lava

volcanologist

a scientist that studies volcanic processes

weather

the conditions of the air at a specific place and time

watershed

an area that drains runoff into a body of water

Other animals you might see at the park...

black-tailed deer
California tortoiseshell
Douglas squirrel
golden eagle
gray jay
mule deer
osprey
Roosevelt elk



- 1 bald eagle
- 2 Stellar's jay
- 3 staghorn lichen
- 4 Clark's nutcracker
- 5 whitebark pine
- 6 mountain hemlock
- 7 black-backed woodpecker
- 8 American marten
- 9 mountain lion
- 10 mountain chickadee
- 11 human
- 12 snowshoe hare
- 13 short-tailed weasel
- 14 golden-mantled ground squirrel
- 15 marmot